CONTRACT [redacted]

25X1

PAR 217 ILLEGIB

8 Sept 64

[redacted]

SUBJECT: Optimization of Lasers

TASK/PROBLEM

1. Explore the production of 0.53-micron (blue-green) laser radiation by harmonic doubling in KDP and ADP crystals.

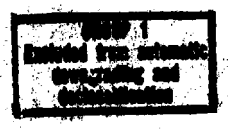
DISCUSSION

2. During this quarter, a complete laboratory setup as designed and assembled to make quantitative measurements of the second harmonic output from a KDP crystal illuminated by a neodymium laser. The purpose of the setup is to enable simultaneous measurements to be made of the 1.06-micron laser energy incident on a KDP crystal and the 0.53-micron second harmonic energy generated in the crystal. The detecting devices for these two wavelengths are photo tubes; an S-4 surface for the 0.53-micron radiation and an S-1 surface for the 1.06-micron radiation.

3. The need for the 1.06-micron monitor was twofold. First, the total laser output must be measured to determine the harmonic conversion efficiency. Second, the energy density to which the KDP crystal can be exposed without physical damage will be a function of input radiation, and this threshold level must be determined.

4. Initial measurement made with this setup utilized a KDP crystal approximately 1-inch square and 0.5-centimeter thick. The data indicated that with 36 joules of 1.06-micron radiation incident on the crystal, a conversion efficiency of $3 \times 10^{-4}\%$ was obtained. With 120 joules of 1.06-micron radiation incident on the crystal, the efficiency increased to $10^{-3}\%$.

5. Although these efficiencies are low, they show excellent agreement with the theoretical linear relationship between conversion efficiency and input energy.



6. In an effort to determine the cause of the low conversion efficiency, a study was made of the crystal orientation. The results showed that the crystal normal and crystal optical axis (Z axis) were properly oriented at 46 ± 0.5 degrees. However, the X axis of the crystal was found to lie in a plane parallel to the crystal surface, an orientation which produces a minimum of second harmonic output.

7. To verify this, a skew mount for the crystal was devised and additional data were taken. These results showed a definite increase in the conversion efficiency. However, the combination of reflection losses at the large incident angles, vignetting by the crystal and skew mount, and the lack of an absolute angular reference precluded any quantitative measurements.

8. Three additional crystals were ordered, oriented such that their X and Y axes make equal angles with the plane of the crystal surface, the optimum orientation for second harmonic output. Two of the three crystals will be two centimeters square and 1 cm thick; the third will be 1 cm square and 1-inch thick. It is anticipated that the optimized orientation and the increased crystal thickness will increase the conversion efficiency several orders of magnitude.

PLANNED ACTIVITY

9. Next quarter quantitative measurements will be made of the second harmonic performance. When these measurements are completed, a program will be set up to evaluate both the second harmonic beam structure and its uniformity by exposing a variety of photographic films.